

Development of Guidelines for Use of Proton Single-Event Test Data to Bound Single-Event Effect Susceptibility Due to Light Ions

Completed Technology Project (2013 - 2014)



Project Introduction

Conventional methods for Single-Event Effects (SEE) Hardness Assurance have proven difficult to adapt to Explorer, Cubesat and other risk tolerant platforms with limited budgets for testing and qualification of components. In this work, we develop Prior probability distributions for SEE to assess and prioritize the risks for design and component selection. By aiding designers in evaluating risk / cost / performance trades for microelectronic and photonic parts at all stages of the design process, it facilitates efficient allocation of limited testing and verification resources. The method also provides a platform for continual improvement over time in platform radiation performance.

Because conventional Radiation Hardness assurance is predicated on having data specific to the part (and possibly on the particular wafer diffusion lot of that part) being considered for flight, it has been difficult to adapt to cubesat, Class-D and other risk-tolerant mission platforms. Indeed, even for missions with low risk tolerance, it has not been possible to place quantitative bounds on risk arising from radiation threats prior to obtaining part-specific data relevant for the application. Often, the best that could be done would be to look at less specific data to seek qualitative reassurance that parts would ultimately fulfill their requirements. Such data include:

Historical Data--radiation test data for the same part type, but different lots tested in the past.

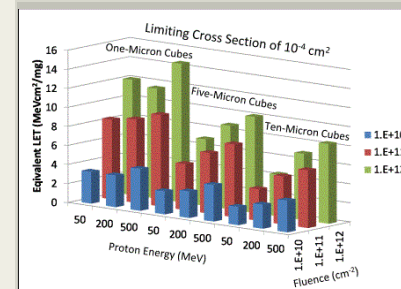
Similarity or Process Data--Radiation test data for similar parts fabricated in the same semiconductor process as the flight parts

Heritage data--data regarding the past successful use of the flight parts in previous similar missions

Each of these data types poses challenges, and to date, use of these types of data has been qualitative. We propose use of Bayesian probability to use these data types to develop quantitative radiation risk metrics.

For short, risk-tolerant missions, often the most significant risks arise from single-event effects, which due to their Poisson nature can occur at any time during the mission. Because single-event effects susceptibility is usually considered negligible from one wafer diffusion lot to another and from part to part within a wafer diffusion lot, we concentrate on use of similarity data and heritage data. The method addresses ways to limit the influence of the initial prior probability distribution so that the resulting distributions and discusses ways to develop statistics that are relevant to the SEE risks being considered, but still form compact distributions in the analysis. The attached paper and presentation give details and the general philosophy of the method.

Anticipated Benefits



Maximum LET from Proton Recoils

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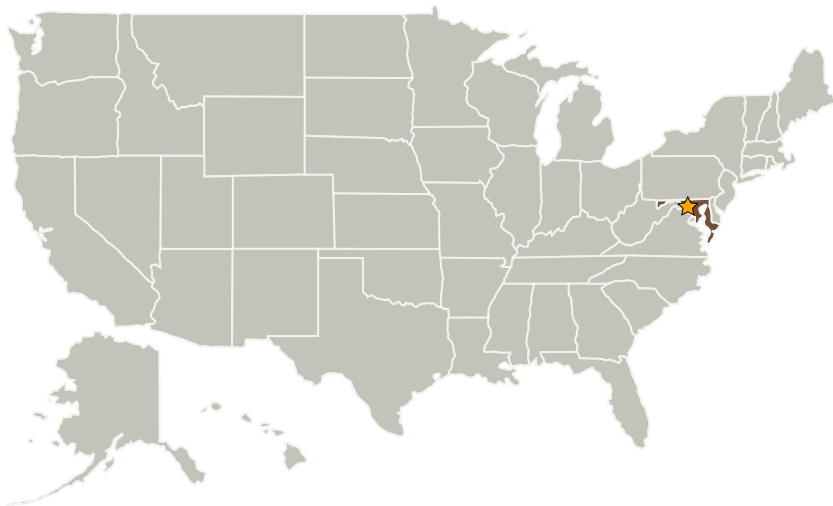
The project identifies semiconductor processes most likely to succeed in a challenging radiation environment. This knowledge is already being applied for GOLD and OSIRIS-REx

The technology and knowledge from this project can benefit any mission that is in a sufficiently early stage of development that components and design can still be influenced.

Commercial space projects are making increasing use of commercial off the shelf technologies, the ability to bound risk arising from single-event effects at all stages of the mission will be useful.

Because many DOD space projects are making increasing use of commercial off the shelf technologies, the ability to bound risk arising from single-event effects at all stages of the mission will be useful.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

Wesley A Powell

Principal Investigator:

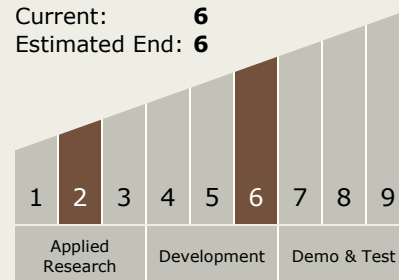
Raymond L Ladbury

Technology Maturity (TRL)

Start: 2

Current: 6

Estimated End: 6



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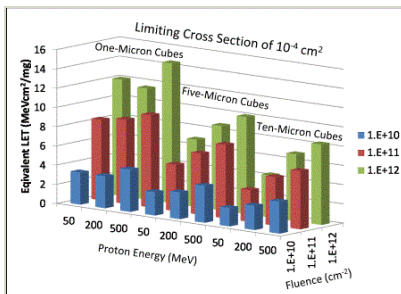
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Primary U.S. Work Locations

Maryland

Images



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Maximum LET from Proton Recoils
(<https://techport.nasa.gov/image/3991>)

Links

Bayesian Methods for Bounding Single-Event Related Risk in Low-Cost Satellite Missions
(<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6665099>)

Project Website:

<http://sciences.gsfc.nasa.gov/sed/>

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
 - └ TX06.5 Radiation Transport and Risk Modeling

Other/Cross-cutting:

- TX02 Flight Computing and Avionics
 - └ TX02.3 Avionics Tools, Models, and Analysis
 - └ TX02.3.2 Space Radiation Analysis and Modeling